Vol. 14(33), pp. 1693-1712, October, 2019
DOI: 10.5897/AJAR2018.13541
Article Number: C0AB18A62036
ISSN: 1991-637X

http://www.academicjournals.org/AJAR

ACADEMIC JOURNALS
expand your knowledge

African Journal of Agricultural Research

Full Length Research Paper

Inventory on banana (Musa spp.) as trading commodities in Maluku islands, Indonesia

Leunufna Semuel[1*], Woltering Ernst[2], Hogeveen- van Echtelt Esther[2] and Van der Waal Johannes[3]

[1]Center for the Conservation of Maluku's Biodiversity (CCMB), Faculty of Agriculture Pattimura University Ambon, Maluku, Indonesia.
[2]Food and Biobased Research, Wageningen University and Research, Netherlands.
[3]AgroFair Company, Barendrecht, Netherlands.

Received 12 September, 2018; Accepted 29 November, 2018

This study was conducted with the aim of providing the latest situation on banana genotypic diversity present in the market places, their cultivations, their market chain and trading facilities in Maluku Province, Indonesia. A survey method was used, in which different markets, farmers and government institutions were visited and interviewed. Seventeen genotypes of three different species and different genome and ploidy levels were found at the market places with two highly demanded genotypes, Pisang Raja Hitam and Pisang 40 Hari. The major suppliers of banana commodities in Ambon markets were Ceram, Ambon, Buru, Obi and Bacan Islands. Lack of knowledge in implementing proper cultural practices, lack of capital, lack of aid provided by government and several other obstacles have been the reasons for low banana production in Maluku Province. Lack of sufficient infra-structure for large scale cultivations, storage and transport, and the use of harmful chemicals in post-harvest handling were some of the factors potentially hindering international trading of banana products. However, there were development plans by the government, which possibly improve banana export situation in the future. As an initial study in terms of value chain analysis in the province, the study should be a reference for further studies of such.

Key words: Banana, plantain, market place, Ambon Island, non-Cavendish, international trading.

INTRODUCTION

Background

Maluku was ranked 17th out of 34 Provinces in Indonesia in Banana productions in 2015. Maluku banana production decreased by about 10.000 tons from 2011 to 2012 but increased since than to reach more than 50.000 tons in the year 2015 out of production areas of 439 ha (Biro Pusat Statistik dan Direktorat Jenderal Hortikultura Kementrian Pertanian RI, 2014 a, b). This production growth reached 32% during 2014 to 2015 (Biro Pusat Statistik dan Direktorat Jenderal Hortikultura, Kementrian Pertanian RI, 2014a). Maluku Islands has also been

*Corresponding author. E-mail: leunufnaunpatti@yahoo.co.id. Tel: + 62-81317978896.

identified as one of the areas with a high diversity of banana germplasm due to its geographical situation within the Wallacea Line. An exploration and collection mission conducted in 2012 in North Sulawesi and North Maluku reported the presence of 29 accessions (species and cultivars) (Hermanto et al., 2012). Other surveys which were still in progress reported 37 genotypes in North Maluku (Sutanto et al., 2013) and 34 genotypes in Central Maluku (Sutanto et al., 2013). Even though about 26 to 67% of the overall cultivars found in North Sulawesi and North Maluku (Hermanto et al., 2012) were sold in the market places with a certain number of popular cultivars, no intensive studies have been reported on the trading of banana in these markets and specifically in Ambon Market.

The need for diversification of banana cultivation and trading, rather than rely on only a few clones of Cavendish banana in the international market, has increased in European countries due to several reasons including susceptibility of Cavendish clones to certain diseases, desires of the consumers for diversification of banana genotypes in international market and the need for organic banana farming to support a healthy life style.

Fusarium oxysporum s. sp. cubense Tropical Race 4 (TR4) fungus causing panama disease or banana wilt have raised scientists' and global attention on the possibility of the disease wiping out Cavendish banana from the international market scene, similar to that done by the Tropical Race 1 to Gros Michel banana in the 1950s (Daniells et al., 2013; Utton, 2017). In addition, black sigatoka or black leaf stike caused by *Micosphaerella fijiensis* Morelet fungus has caused a yield reduction of more than 50% in many banana cultivars including Cavendish banana (Ploetz, 2001). Breeding for resistant cultivars has been among the efforts in combatting the diseases, and therefore, a number of collecting trips and breeding programs have been executed and a number of resistance cultivars have been evaluated (Ploetz, 2001; Nomura et al*.,* 2013; Daniels et al., 2013: Sutanto et al., 2016; Alakonya et al., 2017).

Efforts to introduce certain non-Cavendish bananas into international market have not been very successful due to certain quality requirements (Daniels et al., 2013). The new genotypes have to meet a great number of criteria which, among others, were appearance, taste, distinguishably different, environmental credentials and availability (Daniels et al., 2013).

Considering the opportunity, several institutions in the Netherlands such as Agrofair Company, Berendrecht, Agriculture Department, Netherlands Embassy Jakarta Indonesia, and Food and Biobased Research, Wageningen University have proposed a research and development project in a joint work with the Faculty of Agriculture Pattimura University, Ambon, and the Maluku Provincial Government, Indonesia entitled "Improving local production-distribution chains and creating export possibilities for small (organic) banana farmers in Indonesia".

Prior to an establishment of a road map for further implementation of the project on development of non-Cavendish banana production and international trading, the state of the Art of Banana diversity, cultivation, distribution and trading in Indonesia specifically in Ambon, and Maluku Islands should be provided as a basis for consideration. This study was intended to accomplish the tasks.

Objectives

The objective of the study was to provide data and information on the latest condition related to banana development in Maluku Islands, specifically in Ambon Island Indonesia. The specific objectives were:

1. To enlist the number of banana genotypes both within the sub-group Banana and sub-group Plantain, available as trading commodities at the market places of Ambon Island and provide specific descriptions of those genotypes.
2. To describe trading infra-structures and facilities available for local and international trading
3. To provide information on banana cultivation and cultural techniques implemented in Ambon Island, Indonesia
4. To provide information on governmental surveys regarding Banana cultivations in Maluku Islands.
5. To discuss data and information obtained in relation to further project development.

MATERIALS AND METHODS

The study was targeted to different Musa cultivars/genotypes (Banana and Plantain) found both in the market places and at the growing fields of different areas distributed in Ambon Island. Questionnaires were distributed among traders and producers and, observations were done at the markets to characterize the traded genotypes.

Market data collection

Market data collection was mainly accomplished at the main traditional market "PasarMardika" (Mardika Market) situated at the seashore of Ambon Bay. Several other small traditional markets were visited to, mostly, verify the cultivars enlisted or in some cases identified additional cultivars. Those traditional markets were Pasar Batu Koneng (BatuKoneng Market), Pasar Passo (Passo Market), Pasar Lorong Kantor Pos (Post Office Street Market) and Pasar Lorong Toko Enam (Six Shop Street Market). In addition to traditional markets, modern "Super Markets" were also visited, in this case, Ambon City Center (ACC- Passo), Maluku City Mall (MCM, Tantui) and Ambon Plaza (Ambon City), mainly, to identify the traded cultivars to compare the price given as well as collecting other information.

Data obtained from the market places include local names, geographical areas from where they were obtained, their utilization,

unique characters they possessed (if present), the approximate price, government involvement on the trading and improvement of trader's business etc. (Annex 1). The interviews were done with almost every trader both in formal and informal situations. However, full interviews using questionnaires in formal situations were done to more than 20 traders. Data on number of hands per bunch, number of finger per hand, fruit length, and fruit circle were measured from the samples given at the marked at the time of observation. They were taken randomly from the bunches present (in terms of number of hands per bunch), from different parts of the bunch and hands (in terms of other parameters) in 4 replications. Aside the average values, the range values were also given for each genotype, as the data measured did not only represent the genetic make-up of the genotype but also growing environments, date of harvest etc. A general evaluation on the percentage of a species/cultivar sold in the market relative to the others was done by comparing its frequent and amount present in the market during the period of study in order to determine its relative availability in the market.

Field data collection

Based on the data collected at the market places, some of the main growing areas of Musa were identified, several of them were visited. A field questionnaire was used to evaluate all possible cultural practices theoretically applied to the plants and plantations. The questionnaire presented (Annex 2), however, contains only the cultural practices found in the study, applied by Banana farmers in Ambon Island. Observations and interviews were also conducted with different community members in different villages/sub-villages to obtain data/information on specific Musa species, that is, Pisang Tongkat Langit (*Musa troglodytarum*L.). As many as 15 villages/sub-villages were visited namely Kudamati/Gunung Nona, BatuKoneng, Soya, Naku, Kilang, Hatalai, Waringin Cap, Taeno, Seri, Halong, Tulehu, Waai, Liang, Gunung Nona, Siwang.

Secondary data collections

Visits were made to several government institutions to interview the officials involved in banana developments including plantations and post-harvest business enterprises at local level, national and international level, facilities available for international shipment both through sea as well as air transportation. The institutions visited were Indonesian National Sailing (PELNI), private shipment companies, cargo department of Garuda Indonesia Airways, Provincial Department of Trading and Industry, Provincial Department of Statistics. Literature containing survey's data and information on Musa development were also collected and studied.

RESULTS

Banana (*Musa* spp.) genotypes that were common at the local market places in Ambon Island

The study identified 17 genotypes or cultivars of Banana (*Musa* spp.); eight of plantain and nine of banana sub-groups, with banana being the ones that were consumed raw (un processed), sweet in taste, and plantain being the ones that were consumed after some form of processing (boiled, fried, smoked, etc.) and being more starchy and less sweet. Based on Valmayor et al. (2000) and, Pillay et al. (2006), the 17 genotypes felled into three different species; six genotypes of plantain were interspecific crosses with *M. paradisiaca* L. as one of the parents, two genotypes of *fehi* Banana or Musa *fehi*, or *Musa troglodytarum L*, and nine genotypes of banana, *M. accuminata* Colla. All the six genotypes of interspecific hybridization were triploid with three genotypes belong to the genome ABB and three others AAB; the two *Musa Troglodytarum* L. were of diploid with AA genome while those of banana comprised four genotypes of triploid, AAA, two genotypes of either diploid or triploid, AA/AAA and three genotypes of diploid with AA genome. Identification number refers to the number given to the species/genotype in Table 1.

Pisang Dewaka (Dewaka Banana) (no. 1)

Pisang Dewaka was also recognized in Ambon markets with other names: Pisang Jawaka (Jawaka Banana) and Pisang Abu-Abu Dewaka (Gray Dewaka Banana). It was called Pisang Kepok Besar in Java Island and some other areas in Indonesia, and Malaysia. The name Cardaba was used in Philippines and in international communication. Valmayor et al. (2000) described this genotype as *Musa balbisiana*, an auto-triploid of BBB genome. Other source, however, described it as an allo-triploid, ABB genome derived from the cross between *M. balbisiana x M. acuminata (https://id.m.wikipedia.org/wiki/Pisang_kepok* - Table 1). This genotype was the biggest in fruit size (fruit length and fruit circle) among the three genotypes of Gray Banana, having similar genome (ABB) as well as among most of the Musa genotypes listed except for Pisang Tongkat Langit Panjang (Long Sky-Hold Banana) and PisangTanduk (Horn Banana) (Tables 1 and 2). It produced a similar number of hands per bunch with higher finger per hands in comparison to that of the two genotypes mentioned (Table 2). The fruit is not rounded (more or less rectangular) in shape, dark green in color and yellow when ripen (Table 3). Pisang Dewaka is sold mostly in the form of bunch but also in the form of hands at the price of twenty thousand Indonesian Rupiah (IDR), a price slightly higher than or similar to that of other Musa listed. Pisang Dewaka is consumed mainly at ripening stage, or at yellow fruit color stage, boiled or sometimes smoked and eaten together with fish or other side dishes. This genotype is quite high in demand and frequently present in the market although not in a very high amount. It has about 5% market availability in comparison to other bananas sold in Ambon market (Figure 1).

Pisang Abu-Abu (Gray Banana) (no. 2)

This genotype is often called Small Gray Banana to differentiate it from the Big Gray Banana, which is Pisang Dewaka or Abu-Abu Dewaka. Although it is identified as Small Gray Banana, the length and the circle of the fruit

Table 1. Inventory of Musa spp. (banana and plantain) present at ambon markets.

S/N	Local Name (English Translation)	Synonyms	Scientific name*	Genome*
1	Pisang Dewaka (DewakaBanana), Pisang Jawaka (JawakaBanana), Pisang Abu-Abu Jawaka (Jawaka Gray Banana)	Pisang Kepok Besar (Indonesia), Pisang Chematu, Malaysia), Gardaba (Philippines), Gardaba (Internasional), Chuoi Mat (Vietnam)	*Musa balbisiana/M. acuminate x M. balbisiana*[1)]	Triploid-BBB/ ABB [1)]
2	Pisang Abu-Abu (Gray Banana)	Pisang Kosta (Indonesia), Matavia (Philippines), Pisang Abu Keling (Malaysia), Kluai Hak Muk Khieo (Thailand), Choui NgopLun (Vietnam), Bluggoe, Chato (International)	*Musa X paradisiaca* L.	Triploid-ABB
3	Pisang Abu-Abu Surabaya (Surabaya Gray Banana)	Pisang Kosta Putih (Indonesia), Katsila (Philippines), Pisang Abu Perak (Malaysia), Kluai Hak Muk Khao (Thailand), Silver Bluggoe, Cenizo (International)	*Musa X paradisiaca*L.	Triploid-ABB
4	Pisang Raja Hitam (Black King Banana)	Pisang Raja (Indonesia, Malaysia), Radja (Philippines, International), Kluai Khai Boran (Thailand), Raja (International)	*Musa X paradisiaca* L.	Triploid-AAB
5	Pisang Raja Putih (White King Banana)	Radja (Philippines), Pisang Raja (Malaysia), Kluai Khai Boran (Thailand), Raja (International)	*Musa X paradisiaca* L.	Triploid-AAB
6	Pisang Tanduk (Horn Banana)	Pisang Lang (Malaysia, PisangTanduk in Malaysia wasdifferent type!); Daluyao (Philippines), Kluai Nga Chang (Thailand), l Chuoi Sung Bo (Vietnam)	Musa X paradisiaca L.	Triploid-AAB
7	PisangTongkatLangitPanjang (Long Sky Hold Banana)	Endemic to Maluku Islands and Papua	*Musa fehi, Musa troglodytarum L.*	Diploid – AA [2)]
8	Pisang Tongkat Langit- Pendek (Short Sky HoldB anana), PisangTongkat Langit Bulat (Rounded Sky Hold Banana)	Endemic to Maluku Islands and Papua	*Musa fehi, Musa troglodytarum L.*	Diploid-AA[2)]
9	Pisang Susu Putih (White Milk Banana)	Pisang Susu (Malaysia) Kluai Nam Nom (Thailand)	*Musa acuminata* Colla	Triploid-AAA
10	Pisang Susu Hitam (Black Milk Banana)	Pisang Susu (Malaysia) Kluai Nam Nom (Thailand)	*Musa acuminata* Colla	Triploid-AAA
11	Pisang SusuTarnate (Ternate Milk Banana), Pisang Susu Surabaya (Surabaya Milk Banana),	Pisang Susu (Malaysia) Kluai Nam Nom (Thailand)	*Musa acuminata* Colla	Triploid-AAA
12	Pisang Meja (Table Banana), Pisang Ambon (Ambon Banana)	Pisang Ambon Kuning (Indonesia), Ambon (Philippines), Pisang Embun (Malaysia), Kluai Hom Thong (Thailand), Chuoi Tieu Cao (Vietnam), Gros Michel (Internasional)	*Musa acuminata* Colla	Triploid-AAA

Table 1. Contd.

13	Pisang Warangan Merah (Red Warangan Banana), Pisang Tambaga (Copper Banana)	Pisang Barangan Merah (Indonesia) Pisang Berangan Merah (Malaysia), Lakatan (Philippines), Kluai Ngang Phaya (Thailand)	*Musa acuminata* Colla	Diploid/Triploid - AA/AAA
14	Pisang Warangan Kuning (Yellow Warangan Banana)	Pisang Barangan Kuning (Indonesia) Pisang Berangan Kuning (Malaysia), Lakatan (Philippines), Kluai Hom Maew(Thailand)	*Musa acuminata* Colla	Diploid/Triploid - AA/AAA
15	Pisang Empat Puluh Hari (40 Days Banana), Pisang Tujuh Bulan (7 Months Banana)	Pisang Lampung (Indonesia); Inarnibal (Philippines)	*Musa acuminata* Colla	Diploid-AA
16	Pisang Nona (Girl Banana),	Pisang Gadis (Indonesia), Morong Princesa (Philippines), Kluai Thong Ruang (Thailand), Choui NguThoc (Vietnam)	*Musa acuminate* Colla	Diploid-AA
17	Pisang Jarum (Needle Banana)	Ea-an (Philippines), Pisang Jarum (Malaysia), Pisang Cici Merah, Pisang Cici Kuning (Indonesia), Kluai Nam Thai (Thailand)	*Musa acuminata* Colla	Diploid-AA

*Scientific names and genome levels, synonyms given were based mainly on Valmayoret. al. (2000) except ploidy level and genome of *Musa troglodutarum* L., [1](https://id.m.wikipedia.org/wiki/Pisang_kepok (2018); [2] Pillay et al. (2006).

Table 2. Phonotypical features of different banana genotypes.

S/N*	Number of Hands per Bunch**	Number of Fingers per Hand **	Finger length (cm)**	Finger Circle (cm)**	Fruit Color at young stage	Fruit Color at ripen stage
1	(5 -12) 9.25	(15 -20) 18.25	(19 -23) 21.5	(16 – 18) 17	Dark green	Yellow
2	(6 -15) 10	(17-20) 18.75	(12 – 17) 15.5	(15 -16) 15.5	Green to light green	Yellow
3	(8 – 11) 9.5	(10 – 19) 15	(14 – 19) 15.75	(12 -13) 12.38	Grayish green	Yellow
4	(5 – 10) 7.75	(14-16) 14.5	(13- 17) 15	(13- 17) 14.75	Dark green	Yellow
5	(6 – 20) 15.5	(13 – 18) 15.25	(17 – 19) 17.5	(112– 14) 12.63	Light green	Yellow
6	(2 – 3) 2.25	(6 – 14) 10.5	(20 – 37) 29	(15-20) 17.25	Green	Yellow
7	(4-8) 6	(5-11) 7.5	(23 – 27) 25.13	(8-19) 15	Shiny green	Yellowish red to red
8	(8 – 10) 9.75	(8 – 10) 7.5	(12 – 13) 12.25	(13-14) 13.75	Shiny green	Yellowish red to red
9	(6-10) 8	(14 – 25) 18.5	(11 – 13) 11.88	(11-12.5) 11.5	Light green	white
10	(7 – 10) 8.5	(14 – 18) 15.75	(15 – 17) 15.75	(12 – 14) 12.75	Green	Yellow tainted with black spots
11	(8-18) 12	(15 – 43) 31	(10 – 17) 14	(11 -13) 11.8	Green	Yellow
12	(4 -10) 7	(14-15) 14.25	(14 – 22) 19.25	(13-16) 14.75	Green to light green	Yellowish green to white green
13	(5 – 10) 7.25	(7-12) 11.5	(15 – 18) 16.5	(15 – 20) 17	Purplish red	Purplish red
14	(5 – 7) 6.25	(9-12) 10	(16 -18) 16.75	(16-19) 18	Shiny green	Shiny yellow
15	(8-10) 9.25	(16-23) 20.75	(7,5 – 13) 11.38	(10-12) 10.5	Light green to green	Yellow
16	(8 – 10) 7.75	(11 - 25) 20	(10-11.5) 10.88	(11 -11.5) 11.25	Light green	Yellow
17	(8-10) 9	(13 - 21) 12.25	(9 – 14) 12.5	(8,5 – 10) 9.13	green	Yellow

*The numbers correspond to the genotypes listed in Table 1. **) Numbers represent the range (in the brackets) followed by the average.

can be as high as other Musa genotypes due to variability in growing environment. The genotype produces slightly higher number of hands per bunch and finger per hand relative to the other two genotypes of the same genome, ABB, triploid and maybe named as Pisang Kosta (Kosta Banana) in many other parts of Indonesia (Valmayor et al., 2000) (Tables 1 and 2). It has, however, shorter finger length than the other two and higher finger circle than

Table 3. Market Characteristics of Different Banana Genotypes in Ambon Island.

S/N*	Banana/ Plantain	Processing (consumption) possibility	Price	Indication of nutritional content and/or taste feature	Frequency of availability in the market	Market Demand
1	Plantain	Boiled	20.000 IDR/Hand	Starchy	Frequent	Moderate
2	Plantain	Boiled, fried, kolak,	10.000 IDR/10-15 fingers	Starchy	Frequent	Moderate
3	Plantain	Boiled, fried, kolak,.	20.000 IDR/Hand	Starchy	Seldom	Low
4	Plantain	Raw, boiled, fried	20.000 IDR/Hand	Starchy and sweet	High	Very high
5	Plantain	Raw, boiled, fried	15.000-20.000 IDR/Hand or 65.000 IDR/4-5 Hands	Starchy, not so sweet, astringent taste	Seldom -frequent	Low
6	Plantain	Fried, boiled, smoked	10.000 IDR/3 fruits	Starchy	Frequent	Low -moderate
7	Plantain	Boiled, fried. smoked	10.000 IDR/3 fingers	Medicinal	Seldom -frequent	Low
8	Plantain	Boiled, fried, smoked	15.000 - 20.000 IDR/Hand	Medicinal	Seldom	Low
9	Banana	Raw (non-Cavendish, Desert)	10.000 - 15.000 IDR/Hand	Sweet	Frequent	High
10	Banana	Raw (non-Cavendish, Desert)	10.000 - 15.000 IDR/Hand	Sweet	Frequent	High
11	Banana	Raw (non-Cavendish, Desert)	20.000 IDR/hand	Sour/ sweet	Seldom	Low
12	Banana	Raw (desert)- Non-Cavendish	20.000 - 35.000 IRD/Hand	Sweet	Frequent	Moderate
13	Banana	Raw (dessert)	25.000 IDR/hand	Sweet	Very seldom	Low
14	Banana	Raw (dessert)	20.000/IDR/hand	Sweet	Seldom	Low
15	Banana	Raw (dessert)	10.000 - 15.000 IDR/Hand	Sweet	High	Very high
16	Banana	Raw (dessert)	20.000 IDR/hand	Sweet	Seldom	Low
17	Banana	Raw (dessert)	10.000 - 15.000 IDR /hand	Sweet, medicine	Frequent	Moderate

*The numbers correspond to the genotypes listed in Table 1.

Figure 1. Pisang Dewaka (Dewaka Banana or Gray Dewaka Banana), *Musa x paradisiaca* L. of Plantain sub-group.

that of Pisang Abu-Abu Surabaya. The genotype showed a pale yellowish-white up to yellow color at ripening stage while at the young stage; it exhibits light green to dark green color at the upper part of the fruit and white color at the bottom part of the fruit. The fruit is mostly rectangular; though some are triangular (not rounded) in shape. The genotype is frequently found in the market and sold in the form of hands or group of single fruits at a relatively lower price (10.000 IDR) than other genotypes listed (Table 3). It is well sold in the form of fried Banana (Pisang Goreng), but the taste is not as sweet as that of Pisang Raja Hitam. Pisang Abu-Abu is also consumed in the form of boiled banana (Pisang rebus), *Kolak* Banana (cooked with coconut milk and brown sugar), as well as a material for "KrepekPisang (Banana crackers) home industry (Table 3). The genotype is frequently seen in the

Figure 2. Pisang Abu-Abu (Gray Banana), *Musa x paradisiaca* L. of plantain sub-group.

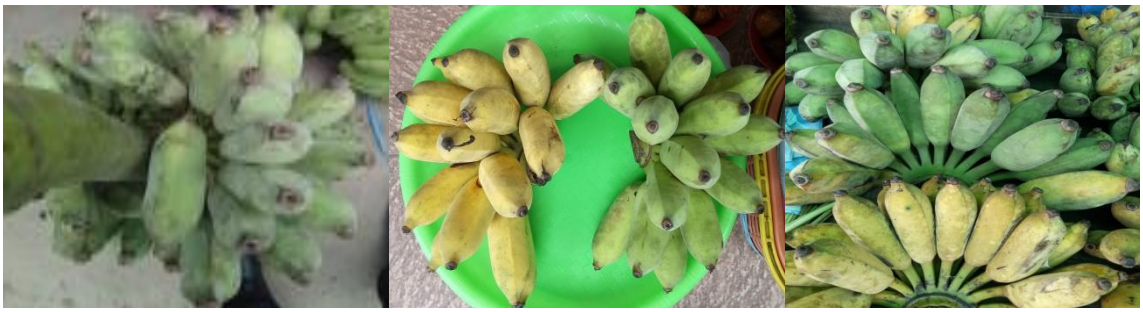

Figure 3. Pisang Abu-abu Surabaya (Surabaya Gray Banana), *Musa x paradisiaca* L. of Plantain sub-group.

market but not in a very high amount. The market availability is approximately 8% in comparison to other bananas sold (Figure 2).

Pisang Abu-Abu Surabaya (Surabaya Grey Musa) (no. 3)

Going by the name, Pisang Abu-Abu Surabaya might have been introduced to Maluku through Surabaya, the capital city of East Java Province. In other parts of Indonesia, it is called Pisang Kosta Putih (Valmayor et al., 2000) most probably for the greyish/whitish color of the fruit at young stage (Figure 3). The genotype has a highest number of hands per bunch among the three genotypes of genome ABB (*Musa x paradisiaca* L.), and a lower number of fingers per hand among the three. It is, however, generally shorter than Pisang Dewaka and slenderer than both Pisang Dewaka and Pisang Abu-abu (Tables 1 and 2). The fruit is relatively straight, rounded with slight angular in shape, grayish-green in color when unripe and yellow at ripening stage. It is consumed mostly at ripening stage after being boiled, fried, and smoked. This genotype is not often encountered in the market since it is not much in demand. When present, usually it is at the amount of a couple of bunches and sold at 20.000 IDR per hand (Table 3). The relative availability in the market is, therefore, very low, about 2%.

Pisang Raja Hitam (Black King Banana) (no. 4)

Two genotypes of King Banana of triploid, AAB genome are present in Ambon Market and resemble each other too well. The name Black King Banana, exhibiting dark green skin color at the unripe stage, was given mainly to quickly distinguish the genotype from the White King Banana exhibiting light green skin color at the unripe stage. In other parts of Indonesia, Malaysia, Philippine (Valmayor et al., 2000) (Table 1) and Hawaii (Kepler, 2007), the name Pisang Raja with AAB genome is also given, but the distinction between Pisang Raja Hitam and Pisang Raja Putih is not specifically indicated. The genotype produces an average number of hands per bunch (7.75), number of fingers per hand (14.5), finger length (15 cm) and finger circle (14.75 cm) relative to other genotypes listed (Table 2). The fruit is not smoothly rounded, is bent at the middle part and yellow in color at the ripening stage. Pisang Raja Hitam is the genotype with the highest amount in market places daily similar to that of Pisang 40 hari. This genotype is brought to the market mainly from the areas of Gemba, Waipia, Kairatu

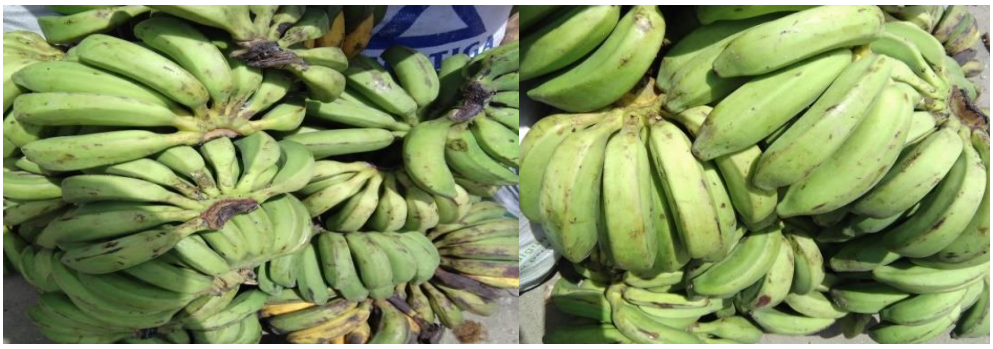

Figure 5. Pisang Raja Putih (White King Banana), *Musa x paradisiaca* L.) of plantain sub-group.

Figure 6. PisangTanduk (Horn Banana), *Musa x paradisiaca* L. of plantain sub-group.

village etc. of Ceram Island. Pisang Raja Hitam is sold in the form of hands at the price of 20.000 IDR per hand or in a group of hands tied together at the price of 65.000 IDR at the traditional markets. At the super market, a hand of 14 fruits weighted 2.2 Kg is sold at the price of 34.000 IDR. It is one of the highest demanded Banana in the market place due to its sweet taste and its use in many different products such as fried Banana (serve in coffee houses in Ambon), pisang ijo (green Banana), pisang molen (blended Banana), pisang coklat (brown Banana), as well as krepek pisang (cracker Banana), all of which are prepared and consumed at the ripening stage except for krepekpisang. The market availability of this genotype is estimated to be 20% relative to all genotypes listed (Figure 4).

Pisang Raja Putih (White King Banana) (no. 5)

Pisang Raja Putih is the second of the two King Banana genotypes having similar genome (AAB) and the product of a cross involving *Musa paradisiaca* L. as one of the parents. The genotype produces a higher number of hands per bunch, a slightly higher number of fingers per bunch and a slightly longer finger length than that of Pisang Raja Hitam. It, however, exhibits lower finger circle than that of Pisang Raja Hitam (Table 2). In addition to the fruit skin color at unripen stage, other traits which separate the two include; thickness of skin, in which Pisang Raja Putih possesses a thinner skin and the fruit taste, in which, Pisang Raja Putih exhibits a bitter or an astringent taste compared to that of Pisang Raja Hitam. The genotype is mostly brought together with Black King Banana from Ceram Island and sold in the market in the form of green hands and a number of green hands tied together at the cost of 15.000 IDR to 20.000 IDR and 65.000 IDR, respectively. Although this genotype is frequently served in coffee house as fried Banana, both at the ripen (yellow skin color) and at the unripen stages (green skin color), it is quite low in demand in comparison to that of Pisang Raja Hitam and some other genotypes listed, maybe because of the taste. It is, therefore, not frequently found in the market place (Table 3). The market availability is approximately 2% (Figure 5).

PisangTanduk (Horn Banana) (no. 6)

Even though possessing the same genome (AAB) and ploidy level (Triploid) to that of Pisang Raja Hitam and Pisang Raja Putih (Table 1), Pisang Tanduk is clearly differ from the two, morphologically. The name, Horn Banana was obviously received because of the fruit shape, which more or less resembles a horn. Besides the name Pisang Tanduk, some other names were also given

Figure 7. Pisang Tongkat Langit Panjang (Long Sky-Hold Banana), *Musa troglodytarum* L. of plantain sub-group.

to this genotype in Indonesia and other Southeast Asean countries, such as Pisang Nangka, Pisang Candi, Pisang Gading, Pisang Agung and Pisang Byar (Valmayor et al., 2000 – Table 1). This genotype produces only 2 to 3 hands per bunch which is the lowest number among all genotypes listed. The number of fingers per hand can reach an average of 10.5, which is among the lowest of all genotypes listed (Table 2). It has, however, the longest fruit and the second highest fruit circle among all genotypes listed. Pisang Tanduk is brought to the market, mostly from surrounding villages of Ambon Island, and also delivered from Ceram Island in smaller amount at the unripe or green color stage. The genotype is usually sold at the market in the form of fingers at the price of 10.000 IDR per 3 fingers, consumed mostly as fried Banana but also can be boiled Banana and smoked Banana at the ripening stage (yellow in color). The genotype is present frequently at the market but at lower amount as that of highly demanded Banana, Pisang Raja Hitam. The market availability is about 5% (Figure 6).

Pisang Tongkat Langit Panjang (Long Sky-hold Musa) (no. 7)

Pisang Tongkat Langit (*Musa troglodytarum* L.) received its name from the fact that the bunch produced was erect facing the sky rather than hanging down from the top of the pseudo-stem as that of all other bananas listed. Two genotypes of Sky-Hold Banana are found in Ambon markets, the Short Sky-Holt Banana exhibited shorter fingers and the Long Sky-Hold Banana, which possesses longer finger than the first. Both genotypes are diploid with AA genome (Pillay et al., 2006) and named Musa Fehi or Fehi banana in many other areas in the world (Table 1). The Long Sky-hold banana produces a very small number of hands per bunch (average of 6) and the lowest number (average of 7, 5) of fingers per hand among all genotypes listed (Table 2). It has, however, the second longest finger (average finger length of 25.13 cm) and one of the highest finger circle among all genotypes listed (Table 2). The finger is green to light yellow to yellowish-red, tainted with black colors as it developes from young up to maturity and further to ripening stages. The skin is relatively thicker than other banana genotypes listed. However, it can be very soft when over-ripen. Pisang Tongkat Langit Panjang brought to the market is usually delivered from surrounding areas of Ambon Island by single vendors of native ambones. Long Sky-hold Banana is found mostly at the areas of high altitude, as high as around 566 meters above the sea level (Figure 18) such as that of Hatalai, Soya, Naku, Gunung Nona, Siwang, Taeno Atas, Waringin Cap villages and sub-villages, and not at the areas of lower altitude such as that of Seri, Halong, Batu Koneng, Waai, Liang, and Tulehu villages and Sub-villages, situated near the seashore. At the Halong village, however, it is found growing at the river bank. Other sources indicated the presence of this species (Genotype) at Akon village, the Island of Nusa Laut, growing at the swampy areas, habitat of Sago palm (*Metroxylon Sago* Rotboll), and at Waipia, Ceram Island. The species is known for its medicinal value. It is consumed in the forms of boiled, smoked or eaten raw. Rather than sold in a form of bunch or hands, the genotype is sold in the market in the form of individual fruit of three at the price of 10.000 IDR. Previously, the genotype was quite seldom found in the market places; it became, however, more frequently found recently, due to more research attention (researchers have been visiting the market to look for the genotype) given to the genotype for its high nutrient content and medicinal usage. There is still not a lot of demand for this genotype, however, probably due to its narrow usage in the community in comparison to that of Pisang Raja Hitam and Pisang 40 hari. The market availability is about 5% (Figure 7).

Pisang Tongkat Langit Pendek (Short Sky-Holding Banana) (no. 8)

Short Sky-hold Banana is about a half-length (average of 12.25 cm) of that of the Long Sky-Hold Banana (25.13 cm) (Table 2). This genotype produces higher number of

Figure 8. Pisang Tongkat Langit Pendek (Short Sky-Hold Banana), *Musa Troglodytarum* L. of plantain sub-group.

hands per bunch (9.75) with similar number of fingers per hand (7.5) and lower average finger circle (13.75) than that of Long Sky-hold Banana (Table 2). The two exhibit a similar color at unripe and ripen stages, which are green and yellowish red to red colors, respectively. The short genotype, however, has a dull or not so shiny appearance than that of the Long Sky-hold Banana (Figures 7 and 8). This genotype is like the red Pisang Tongkat Langit described by Valmayor et al. (2000) as opposed to the yellow Pisang Tongkat Langit, which may refer to the Long Pisang Tongkat Langit. It seems that this genotype has not been cultivated frequently, due to its low market demand. Pisang Tongkat Langit Pendek is grown in Kilang village, Ambon Island, producing bunch at the young stage of development (Figure 8). Pisang Tongkat Langit Pendek is usually sold in the form of hands at the price of 15.000 to 20.000 IDR per hand. It is, however, not well demanded for in market places, even though, it possesses medicinal value similar to that of Long Sky-hold Banana. Contrary to PisangTongkat Langit Panjang, which is becoming more frequently found in the market places, Pisang Tongkat Langit Pendek is very rarely found. The market availability is therefore, lower than 1%.

Pisang Susu Putih (White Milk Banana) (no. 9)

Pisang Susu Putih is one of the three genotypes of *Musa acuminate* Colla with triploid and AAA genome present in Ambon market places. Although the three genotypes are usually and can be clearly distinguished among each other for their different characters, they are called with the same name, Pisang Susu, in several Asean countries (Valmayor et al., 2000 – Table 1). The fruit has a smooth skin, rounded, about 12 cm in length similar to its circle, light green in color when young and white when ripe. The bunch can produce around 8 hands; some of the hands can produce up to 25 fingers. The genotype is commonly found in the market places and quite high in demand as dessert for its sweet taste (Table 3). It is sold in the form of hands at the price of 10.000 to 15.000 IDR per hand. The market availability is approximately 7% (Figure 9).

Pisang Susu Hitam (Black Milk Banana) (no. 10)

Pisang Susu Hitam is a genotype having similar traits (ploidy level, genome) with Pisang Susu Putih, except for some physical appearances. Compared to Pisang Susu Putih, Pisang Susu Hitam is lower in number of fingers per hand but higher in fruit length as well as fruit circle; sometimes it is slightly bent in the middle part of the fruit, exhibits a yellow skin color at ripening stage with black spots appearing at different parts of the fruit. It is also sweet in taste and high in demand in the market place mainly for dessert (Table 3). The genotype is brought to the market from the surrounding villages in Ambon Island and sold in the form of hands at the price of 10.000 to 15.000 IDR per hand. Market availability can be 7% (Figure 10).

Pisang Susu Ternate (Ternate Milk Banana) (no. 11)

The fruits produce on hand of this genotype can reach more than 40, ususally the one at the top of the bunch, even though, on average, the fruits produced at the hands are not dramaticly different (lesser than twice as much) from of Pisang Susu Putih and Pisang Susu Hitam. The fruit is straight (not bend) and slightly shorter than that of Pisang Susu Hitam but similar to that of Pisang Susu Putih (Table 2). It is also thinner (has a lower finger circle) than the other two genotypes of the similar name (Table 2). The genotype tastes sweet when fully ripe but at the same time (when unfully ripe) has a sour taste that makes it not well sold in the market places (Table 3). The genotype, therefore, is rarely found and in lower demand in the market in comparison to many other genotypes. When present, it is usually brought to the market from Ambon Island, and sold at the price of 20.000 IDR per hand. The market availability is about 2%

Figure 9.Pisang Susu Putih (White Milk Banana), *Musa acuminata* Colla of banana sub-group.

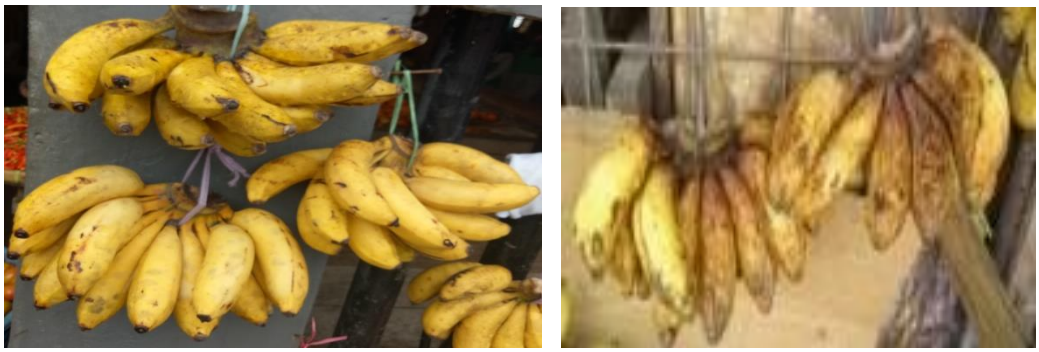

Figure 10. Pisang Susu Hitam (Black Milk Banana), *Musa acuminata* Colla of banana sub-group.

Figure 11. Pisang Susu Ternate (Ternate Milk Banana), *Musa acuminata* Colla of banana sub-group.

(Figure 11).

PisangMeja/Pisang Ambon (Table Banana/Ambon Banana) (no. 12)

Pisang Ambon or Pisang Meja is internationally known as Gros Michel (Valmayor et. al., 2000). This genotype has markedly different features than that of the three other genotypes of the same genomic background and ploidy level (Table 1). It has the biggest fruit size of the fourth (19,25 cm and 14, 75cm finger length and finger circle, respectively) (Table 2), but produces the lowest number of hands per bunch (7) and number of fingers per hand (14,25) among the fourth. The genotype exhibits green to light-green color at the unripe stage and yellowish-green to white-green color when ripe (Figure 12). Beside the Gros Michael, other genotypes of Pisang Ambon such as Pisang Ambon Hijau (Green Ambon Banana), not specifically described here, seem also to be present in the market place. Pisang Ambon, besides consumed by adult as desert, is also frequently used to feed infants. The ones brought to the market from surrounding villages of Ambon Island, usually are fully developed, mature

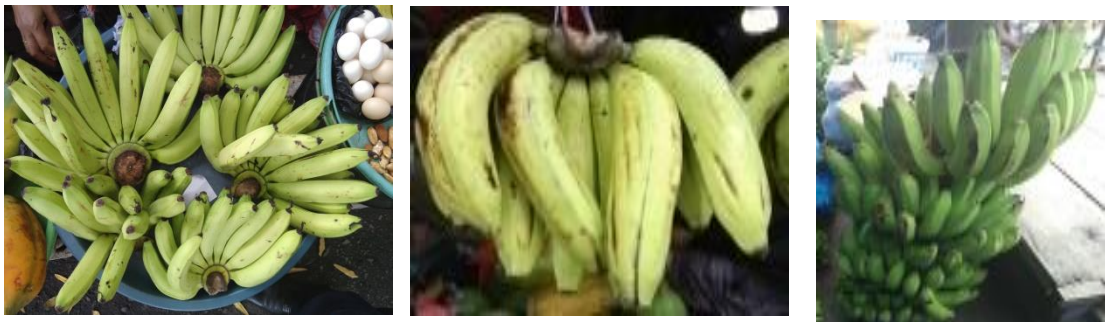

Figure 12. Pisang Meja/Pisang Ambon (Table Banana/Ambon Banana), *Musa acuminata* Colla of banana sub-group.

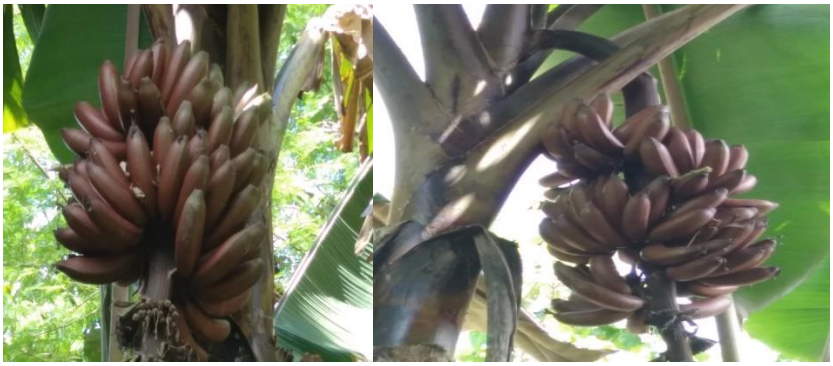

Figure 13. Pisang Warangan Merah (Red Warangan Banana), *Musa acuminata* Colla of banana sub-group.

banana, in comparison to that brought from Ceram Island, which is usually harvested at an earlier stage of maturity and not fully developed. It is sold in the form of hands at the price of 20.000 to 35.000 IDR per hand. It is frequently present in the market, although, not as high amount as that of highly demanded Banana such as Pisang Raja Hitam and Pisang 40 Hari. The market availability is approximately 7%.

Pisang Warangan Merah (Red Warangan Banana) (no. 13)

Pisang Warangan Merah (Red Warangan Banana) also called Pisang Tambaga (Copper Banana) is one of the two genotypes having auto diploid or autotriploidploid level, with AA or AAA genome, of the species *Musa acuminate* Colla found in Ambon markets (Table 1). The name Red Warangan Banana and/or Copper Banana obviously refers to the fruit skin color, which is red or copper or purplish red. The same names for the two used in many parts of Indonesia and Malaysia, but with a small differences in that Barangan and Berangan are used in the two countries, respectively (Valmayor et al., 2000). Pisang Warangan Merah genotype produces a slightly higher number of hands per bunch and number of fingers per hand, but slightly lower finger length and finger circle than that of the other genotype of the same genome and ploidy level, Pisang Warangan Kuning (Table 2). The color of the skin usually stays more or less the same from the young up to mature stages that makes it a bit hard to determine the ripening stage of the fruit. It is very seldom found at the market places. It is, however, found grown at private yards or near the street or even at the University Campus yard (Arboretum) in a small (one or two) stands (plants). Although this genotype is quite attractive or unique in terms of fruit color, it is very less in demand at the market places probably due to the fact that the genotype is not well known within the community. The market availability is, therefore, lower than 1% (Figure 13).

Pisang Warangan Kuning (Yellow Warangan Banana) (no. 14)

This genotype is very close in terms of phonotypical features measured to that of Pisang Warangan Merah, which possesses the same ploidy level of either diploid or triploid and genome of either AA or AAA (Valmayor et al.,

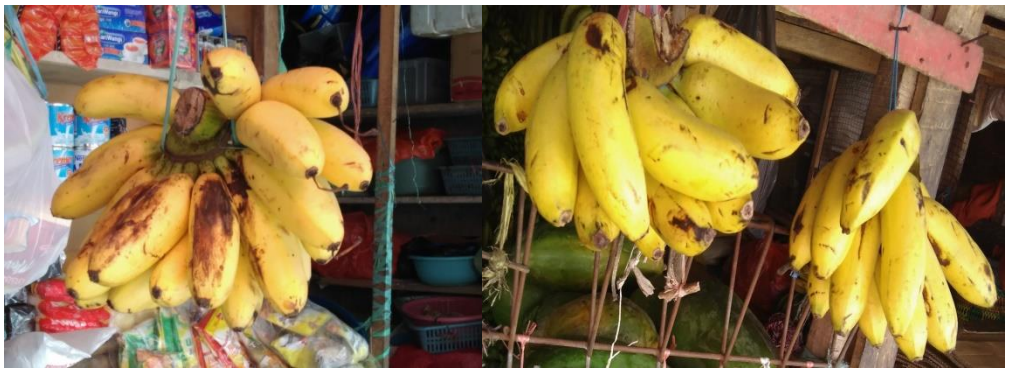

Figure 14. Pisang Warangan Kuning (Yellow Warangan Banana), *Musa acuminate* Colla of banana sub-group.

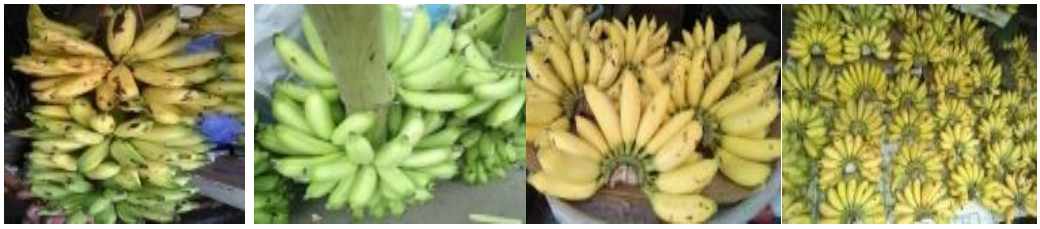

Figure 15. Pisang 40 Hari (40 Days Banana), *Musa acuminata* Colla of banana sub-group.

2000 -Table 1). Both genotypes produce similar number of hands per bunch, fruits per hand, fruit length and fruit circle (Table 2). The difference between the two is seen clearly only on the fruit skin color, which is yellow for the Pisang Warangan Kuning at ripening stage and shiny green at the young stage (Figure 14 and Table 2). The genotype is supplied to the market places from the surrounding villages of Ambon Island. It is consumed as dessert and sold in the form of hands at the price of 20.000 IDR per hand (Table 3). This genotype started to increase in demand but not many are grown by the farmers and therefore less in market supply. Some traders indicate that they are willing to sell this genotype when they are supplies. Market availability is deemed to be 2%.

Pisang Empat Puluh Hari (40 Days Banana) (no. *15)*

Pisang 40 Hari (40 Days Banana) received its name because it takes about 40 days from the appearance of inflorescence up to maturity stages of the fruit. It is also called Pisang Tujuh Bulan (Seven Months Banana) for the fact that the vegetative growth/development of this genotype lasts for seven months before the onset of the inflorescence. It is a diploid with AA genome, of the species *Musa acuminate* Colla, similar to two other genotypes**,** Pisang Nona (Girl Banana) and Pisang Jarum (Needle Banana) (Table 1). It produces a quite high (9, 25) number of hands per bunch, the highest number of fingers pe hand (20,75), but one of the shortest finger (11,38 cm) and the smallest finger circle (10,5) among all genotypes listed (Table 2). The fruit is rounded; light green to green in color when young and yellow when ripens. The genotype is sold in the form of hands at the price of 10.000 to 15.000 IDR per hand at the traditional market. In the super market, a hand of 20 fruits, about 0.88 Kg is sold at the price of 16.000 IDR). It is one of the very few genotypes sold in the super market of Ambon Island. It is found daily in the market places, very well sold or very high in demands in the market places for its sweet taste and its role in many different occasions (celebrations) within the families and community of Ambon Island. It is one of the two genotypes with the market availability of about 20% (Figure 15).

Pisang Nona (Girl Banana) (no. *16)*

Pisang Nona is also called Pisang Gadis in some other parts of Indonesia (Nona was ambones word for girl similar to gadis in Indonesian language). Several other names (may also be of different cultivars) used for this genotype are Pisang Mas, Pisang Pinang, Pisang Jari Buaya, Pisang Masam, Pisang Lidi, in Indonesia and Malaysia (Valmayor et al., 2000 – Table 1), as well as in

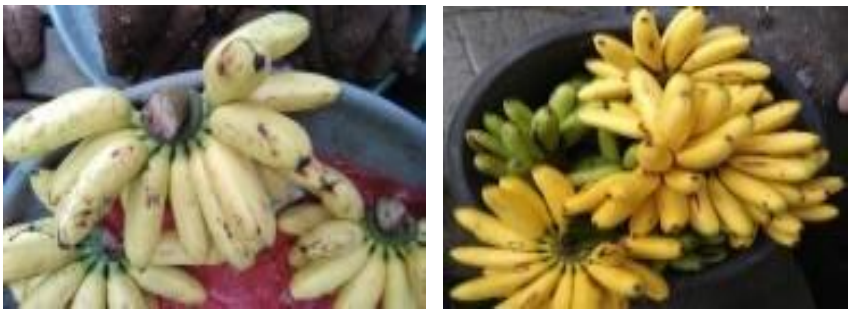

Figure 16. Pisang Nona (Girl Banana), *Musa acumunata* Colla of banana sub-group.

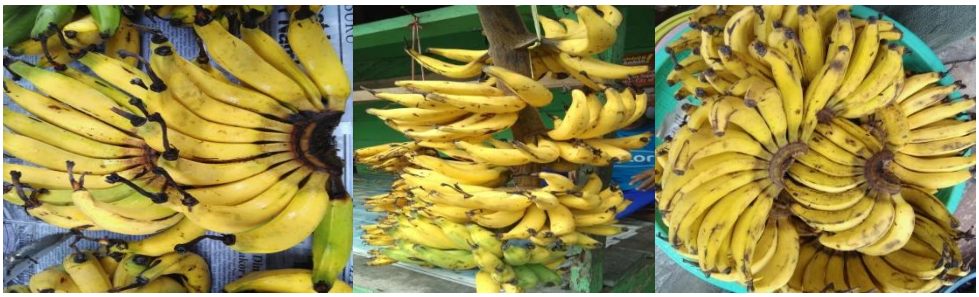

Figure 17. Pisang Jarum (Needle Banana), *Musa acuminata* L. of banana sub-group.

Hawaii (Kepler, 2007). Phenotypical features measured for Pisang Nona are as follows (Table 2); it produces the lowest number of hands per bunch (7,75) among the three genotypes of the same genome and ploidy level, slightly lower (20) in the number of fingers per hand than that of Pisang 40 Hari but much higher than that of Pisang Jarum. It is the shortest in fruit length (10, 88 cm) but the highest in fruit circle (11, 25 cm) among the three. Pisang Nona is another genotype brought to the market places from the surrounding villages in the mountains of Ambon Island. It is usually fully developed and at the ripening stage, found mostly at the traditional markets of Jalan Lorong Toko Enam, Jln. Lorong Kantor Pos and the main market, Mardika Market. The genotype exhibits green color when unripe and yellow color when ripe and consumed mainly as dessert for its sweet taste (Figure 16 and Table 3). Previously, it was rarely found and low in market demand. Recently, however, its market availability increased, estimated to be 2% relative to all genotypes listed.

*PisangJarum (Nidle Banana) (***no. *17)***

Pisang Jarum is the smallest banana found in the market places of Ambon Island. It is a skinny, tapering fruit (sometimes slightly bigger at the base and continuously decreasing in fruit circle as it goes to the top of the fruit). According to Valmayor et al. (2000) the name Pisang Jarum was also used in Malaysia but not commonly used in other parts of Indonesia; instead, it was called Pisang Cici with two different genotypes, Cici Merah (Red Cici) and Cici Kuning (Yellow Cici); both are not specifically distinguished here. This genotype is found quite frequent at the market places including Batu Koneng Market, Jl. Lorong Kantor Pos Market and Mardika Market. Other than consumed as desert, the genotype also has a medicinal function and mostly bought by the Chinese community (Figure 17 and Table 3). The market availability is about 5%.

Cultivation, logistic and post-harvest handling

Field cultivation of Banana (*Musa* spp.) in Ambon Island was conducted at various different areas including at private yards, empty lands near the roads, arboretum of the University, dusun (agroforestry system), in a cropping system of multiple cropping, and at an elevation started from near the seashore up to the mountains. Monoculture system of growing banana was rarely found. When existing, however, it is mostly in a very small scale and without proper implementation of cultural techniques. Cultivations in greater scales in Maluku Province were mostly conducted in Ceram Island, some in monoculture systems, usually by migrants from Java and Celebes.

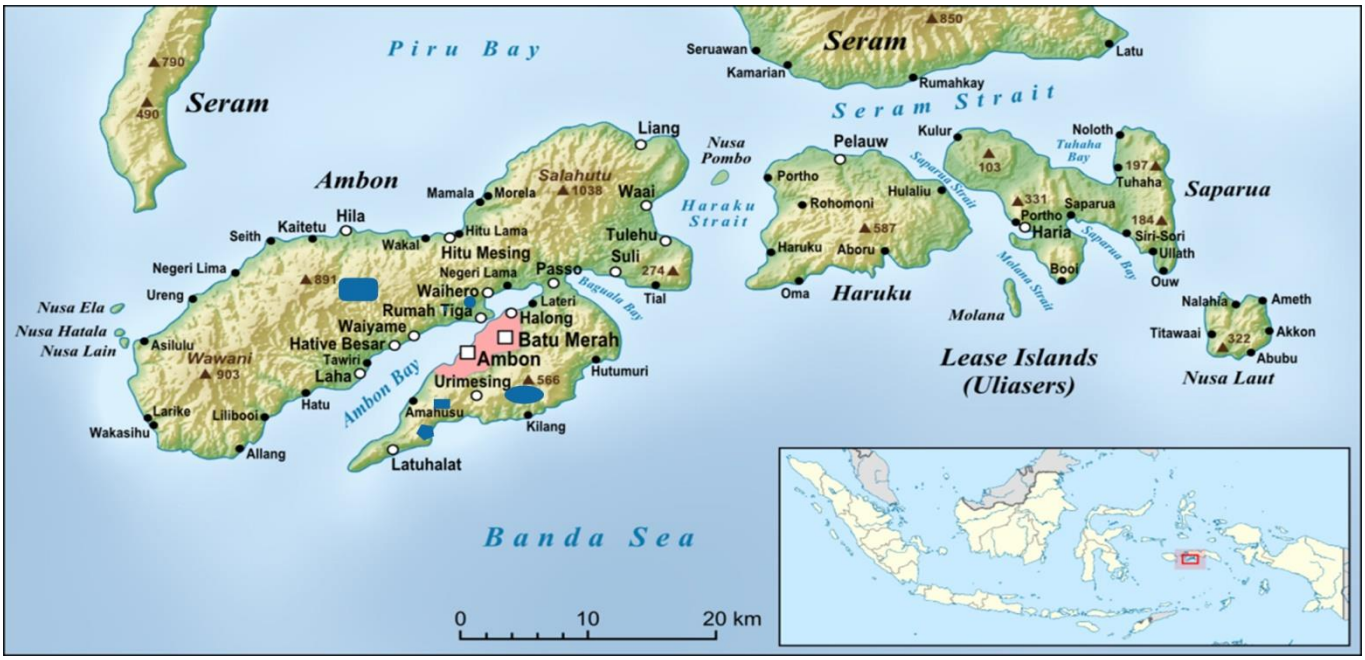

Figure 18. Map of Ambon Island showing the surveys' areas especially for PisangTongkat Langit *(Musa troglodytarum* L.). The blue rounded rectangle, as high as 891 meter above the sea level is the area of Waringin Cap and Taeno Atas sub-Villages. The blue elliptical circle, as high as 566 meter above the sea level is the area of Soya, Naku, Hatalai Villages. The blue rectangle, slightly lower than 566 meter above the sea level, is the area of Gunung Nona and Siwang sub-Villages. The blue octagon is the Seri Village. The blue round circle is the Batu Koneng area. Batu Koneng, Seri, Halong, Tulehu, Waai and Liang Villages and sub-Villages are situated near the seashore (LencerCC BY-SA 3.0).

The Bananas were harvested at the green stage of maturity (unripe) and collected in bunches or in a number of hands tied together by farmers, traders or collected traders at their houses before transported further. No packaging system or other treatments were applied at this stage. The species/genotypes and/or cultivars brought to the market from Ceram and other islands composed mainly of Pisang Raja Hitam, Pisang Raja Putih, Pisang Dewaka, Pisang Abu-Abu, Pisang Abu-abu Surabaya, Pisang Empat Puluh Hari, Pisang Warangan Merah, Pisang Warangan Putih and Pisang Jarum. The bananas entering the market from Ambon Island are mostly harvested at the stage of fully developed fruits and yellow in color (ripen). These bananas are mainly carried in the form of hands on a tray (Dulang) on the head by ladies wearing traditional clothing (Kain-Kabaya) of Ambon Island. Recently, however, bunches of banana carried in a "microlet"(public transportation) to the market also taken place frequently. The cultivars/species mainly include; Pisang Empat Puluh Hari, Pisang Tongkat Langit, Pisang Ambon/Pisang Meja, Pisang Jarum, Pisang Nyonya, Pisang Susu Putih, Pisang Susu Hitam, Pisang Susu Ternate, and in a lesser amount; Pisang Tanduk, Pisang Raja Hitam Pisang Raja Putih and others. The genotype is mostly introduced from South of Buru Island as well as from Obi and Bacan Islands (North Maluku Province) was Pisang Abu-Abu.

Movements of fresh banana from different places and islands to the market places in Ambon Island are facilitated by trucks and ferry ships, from Waipirit Ferry Harbor to Liang Ferry Harbor for two hours in case of Ceram Island and from Namlea Harbor to Galala Ferry Harbor for one night in case of Buru Island. In case of Obi and Bacan Islands, transportation is accomplished by the use of small ships, regularly landed at the small harbor near the central traditional market, Mardika market. Small trollies developed by traders will then be employed in moving the bananas to every trader within the market place. In case of supply coming from within Ambon Island, harvested bananas are both carried using micro-lets (City transportations) as well as by ladies of the mountain villages, wearing traditional clothing. Several small trading places, which by many, are also used as secondary living houses, are provided by the city government and purchased by the traders. The traders have to pay also for the garbage management by the city, for the management of parking within the market as well as a tax for city government and local village.

The use of calcium carbide (CaC_2) in fastening the ripening process of banana is mainly practiced by the traders in the markets, especially to those transported from other islands, and in a greater amount. When applied to banana coming from Ambon Island, the main purpose is to control the ripening process to achieve

certain appointment with the consumers. In some practices, the chemical is spread on surrounding or at the outside of clothing used in wrapping the bananas. Dipping into the sea water is also, sometimes, practiced with the same purpose.

Infra-structure and facilities supporting local and international trading

There has not been any substantial business involving banana production, processing and trading identified in Maluku Province. A small business of banana crackers developed in Waipirit area Ceram Island is said to be able to export their products to bigger market outside the province and the country. This business company, however, has not been enlisted or recognized by the government, indicating, it might not been able to meet all requirements needed for a product to be approved by the government.

International trading out of Maluku Province is theoretically supported by ships and by airways. Three to four private shipping companies are operating in Ambon, Maluku Province. The facilities of cold storage, however, are usually not available causing the shipments of horticultural products to be impossible for a long distance marketing such as to Europe. Recently, however, there has been a policy improvement to provide one shipment with cold storage every Month, which was quite promising for the shipment of horticultural products. Another constraint faced in Maluku Province is the procedure of obtaining the permit from custom officers and/or quarantine, which requires the shipments to be first inspected in other cities (Surabaya, Java Island). This procedure will surely prolong the waiting period and will affect the quality of horticultural products such as banana. This procedure is changing now, however, in which, such inspections and documents can be completed in Ambon, the capital of the Maluku Province and, therefore, the shipment can be directly sailed to foreign destinations.

The other way of delivering horticultural products to international destinations is through Garuda cargo. The Garuda Indonesia Airways provides a cargo as heavy as 150 tons for International delivery. The Garuda shipment can take about one and a half day to reach the final destination. However, the packing, inspection of the products, and permit documents still have to be dealt with before shipment.

DISCUSSION

This study indicates that at least 17 different genotypes are being traded dayly in the markets of Ambon, dominated by Pisang Raja Hitam (Black King Banana), Pisang 40 Hari (40 Days Banana), Pisang Abu-Abu (Gray Banana), Pisang Susus Putih (White Milk Banana), Pisang Susu Hitam (Black Milk Banana) and Pisang Meja (Table Banana). These sources of germplasm can be a genepool where selection can be made to find specific genotypes suitable to be developed further to meet national and international market demands.

Trading of banana (*Musa* spp.) in Maluku Province can be said to concentrate mainly at Mardika Traditional Market, Ambon, as the banana commodities traded in this market are supplied from some of the places indicated to be areas with high diversity of banana Germplasm; Ceram, Buru, Ambon, Obi and Bacan Islands. Banana trading in Ambon is dominated by two most highly demanded, most frequently present in the market, in the greatest amount in comparison to the other genotypes sold; Pisang Raja Hitam of Plantain sub-group and Pisang 40 Hari of Banana sub-group. Hermanto et. al. (2012) surveyed the Markets of North Sulawesi and North Maluku and indicated that dominant varieties sold in the markets varied between the regions. They mentioned, however, five most popular varieties sold, which were Kepok Kuning (Cepatu Abu, local name), Goroho Merah, Raja, Berlin and Mas Manado.

Further survey in Central Maluku and Lesser Sunda (Hermant et al., 2013) enlisted 20 genotypes of banana in Ambon Islands, four of them have no local names given while In Ceram Island, 33 genotypes were enlisted and eight genotypes have no local names given. Based on the name listed in Hermanto et al. (2012) and the pictures provided in the working document (Sutanto et al., n. d.), about eleven (55%) genotypes/cultivars were seen at the market places in Ambon while all 17 (51%) cultivars sold in Ambon Market were among the ones found in Ceram Island. Market visit during the survey by Hermanto et al. (2013) reported 33% up to 70% of genotypes found were sold at the market place, with popular cultivars being Kepok, Raja, Berlin Ambon, and Mas Manado. These dominant genotypes mentioned were also found in this study as indicated both by the names and the pictures studied. Pisang Kepok Kuning was another name for Pisang Abu-Abu (Gray Banana), Pisang Berlin was similar to Pisang 40 Hari, Pisang Mas Menado was similar to Pisang Nona (Girl Banana) while Pisang Raja (King Banana) and Pisang Ambon or Pisang Meja (Ambon Banana or Table Banana) were the same names listed in Table 1. These facts also indicated that most of the *Musa spp*. distributed in Central Maluku Regency (Ceram and Ambon Islands), despite their potentials and importance in taxonomic study, bio-prospecting as well as being as sources of breeding materials, still have no niche, at this moment, as trading commodities at the market place.

Low percentage of market availability of many cultivars relative to one another present in the market, as well as relative to number of cultivars present in the islands signaling the loss of genetic diversity among banana genotypes in Maluku Islands. Studies in Pacific Islands

from New Guinea, Tahiti and Hawaii islands (Kagy et al., 2017) indicated previous abundance of genotypes in the area and attributed the cause of genetic erosion to the introduction of new sweet Cavendish banana in the 19th century. They established field and in-vitro collections as long-term conservation strategy for banana, which supported public education, initiated the awareness and as preservation for next generations.

PisangTongkat Langit (*Musa troglodytarum* L.) is evaluated more specifically in this study partly because Maluku is one of the very few areas of endemism and place of origination of the species, and because of its high content of Beta-Carotene as well as its medicinal use. General evaluation indicated that higher altitude with high plants canopy coverage and high water availability were the habitats preferred mostly by this species. It seems, therefore, that low temperature and high humidity were part of the climatic conditions playing important role in its distribution. A study conducted at Lumajang Rejency of East Java Province indicated that Pisang Songgo Langit (similar name for Pisang Tongkat Langit) was found in a small population only at the Village of Sombo with an altitude of 1.500 – 2.000 meters above the sea level and not found at the altitude ranging from 500 to 1500 meters above the sea level (Arifin et al., 2015). Another study in Maluku Islands (Hiariej and Karuwal, 2015), however, found Pisang Tongkat Langit at a number of places including Wakal, Passo and Waai of Ambon Island, Haruku of Haruku Island, Lesluru of Ceram Island and Saparua of Saparua Island, some of which, considered to be of lower altitude. The authors reported a distribution temperature of 13 – 32^0C and humidity of 8 - 32% for this species.

Daniels et al. (2013) divided banana consumers into three different clusters, “Banana Lovers”, “Traditionalist” and “Banana Snobs”. A test among the three clusters revealed that there were differences on their preferences for banana cultivars among “Cavendish”, “Lady Finger” and “High Noon”, indicating there was a gap between consumer’s needs and wants and the existing Banana industry; or in other words, there was a need for other Banana cultivars than just Cavendish in the banana market. Following the preference test, a great amount of development works on different aspects including production system, quality control, market chain, shelf life, etc. still have to be done on the preferred cultivars prior to reaching a broader market. Similar case applies to the cultivars of Ambon markets found in this study.

Infra structures and facilities for international trading in Ambon were not well established. Although a number of shipping lines available for international transport, the absence of reefer logistic makes it difficult for the shipments of horticultural products. In addition, the shipment schedule is prolonged by the facts that certain inspections and legal documents have to be done in other cities (Islands), which is Surabaya before continuing overseas. Air transport of horticultural products is said to be available which will cut short the time of transportations. The packaging and preparation of legal documents on these procedures, however, are still not very well described. There are, however, promising developments, in which, some shipping lines have planned to have one reefer shipment per month. There are also efforts to prepare legal documents needed in Ambon city to speed up the shipment period. The importance of reefer containers, which will maintain a controlled atmosphere low in oxygen and high in CO2 has been indicated by van der Waal (2013) based on the experiences of Peru and Ecuador.

The policy of decentralizing products’ evaluation and documents preparation is necessary to enhance international trading in Indonesia. This policy is needed to be followed by human resources development, in which, local officers are prepared with the knowledge and skills to accomplish such tasks. Establishment of specific branch institution or sub-department to handle these specific tasks may also be necessary to concentrate the efforts and promote the export of many products from the provinces in Indonesia, including Maluku Province.

This study also indicated the use of Calcium Carbide (CaC_2) by some of the traders to speed up the ripening process of traded banana either to be readily available in the market and/or to be able to meet a certain period of consumers’ appointed time. Artificially controlling the ripening process of horticultural products has been practiced in many countries in the world (Ashraf-Ur-Rachman et al., 2008). This practice will allow a product to be harvested at the unripe stage to prolong its postharvest shelf life. Ethylene gas produced by plants is the natural ripening agent but natural ripening can be very slow and unpredictable and, therefore, certain chemicals producing ethylene or acetylene, another ripening agent with similar effects to that of ethylene, have been used in artificial ripening namely, Ethepon and Calcium Carbide, respectively. Ethepon of 39% v/v has been reported to naturally facilitate the ripening fruits without any harmful effect on humans. This chemical is quite expensive causing the traders to implement low cost Calcium Carbide (Ashraf-Ur-Rachman et al., 2008). Application of calcium carbide to the horticultural products will soften the fruit and develop a good pill color but poor in flavor and possibly toxic (Ashraf-Ur-Rachman et al., 2008). The authors, therefore, recommend government (health authority) to pay attention to the illegal practice of using carbide openly.

Maluku banana production is quite low in comparison to the total production in Indonesia, which is slightly less than six thousand tons in the year 2015. This fact can be attributed to several factors including small, inconsistent and irregular production area, lack of agricultural input factors, lack of knowledge in cultivation techniques and farm management. In addition to those direct causes, lack of governmental aids, as indicated by the survey done by Central Biro of Statistics, have left the banana

farmers with very small capitals, no extension services, no farmers groups or lack of participation in farmers groups, lack of tools and farming machineries, vulnerability to the disasters and climate change, low welfare etc. (Anonymous, 2013b). While the conditions described above will be challenges in attempts to improve banana production and business in Maluku Islands, they also indicated the possibility to improve banana production, management, cultivation system (that is organic cultivation) and business as well as farmers' economic/living conditions by providing aids needed to tackle the problems.

Conclusion

As many as 17 genotypes/cultivars of banana both of the banana and plantain sub-groups are being traded daily in the market places of Ambon city, Maluku Province, Indonesia, with the dominant cultivars being Pisang Raja Hitam of Plantain sub-group and Pisang 40 Hari of Banana sub-group. The main suppliers of the banana in the market places in Ambon are Ceram Island, Ambon Island followed by Buru Island, and Obi and Bacan Islands. The present banana genotypes can be further selected and developed for international market when possible. International trading of banana from Ambon Island has not been possibly taken place at this point in time due partly to inadequate infra-structure and facilities. This situation, however, may be changed in the near future with the policy of improvement made by the government as indicated by officials of some of the shipping lines. At the same time the scale of banana productions and farming systems should also be improved to meet the demand of banana local, regional and international markets. Post-harvest treatments to provide longer shelf life as well as to maintain high quality banana products are necessary to facilitate a wider market. The use of harmful inorganic chemicals, however, should be prohibited. There should also be studies aiming at achieving the right concentration of the chemical used in artificial ripening to avoid harmful effects on human.

ACKNOWLEDGEMENTS

The authors thank Agriculture Department Netherlands Embassy in Jakarta, Indonesia, AgroFair, Barendrecht, the Netherlands and Wageningen University for the funding provided. Pattimura University and Maluku Provincial Government are also acknowledged for the support given. We also thank The Center for Statistics Institution (BPS) Maluku Province for the data provided. One of the authors (Semuel Leunufna) thanks Mr. Luud Clercx of AgroFair Company Barrendrecht, Netherlands for providing website-link to recent scientific literatures on Musa spp.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

REFERENCES

Alakonya AE, Ortega-Beltran A, Mahuku GS, Bandyopahyay R, Swennen R (2017). Rapid screening for resistance against *Pceudocercospora* banana pathogens using relatively long detach banana leaves under controlled conditions. International Institute of Tropical Agriculture IITA.

Anonymous (2013b).Sensus pertanian 2013. Angka provinsi Maluku hasil survai ST2013-subsektor rumah tangga usaha tanaman hortikultura, 2014.Buku c tanaman hortikultura. Badan Pusat Statistik Provinsi Maluku, 2013.

Arifin S, Damanhuri, Soetopo L (2015). Observation and characterization of banana (*Musa* spp.) in Gucialit sub-District Lumajang Regency. Jurnal Produksi Tanaman 3(6):480-486.

Ashraf UR, Fazle MD, Billal Alam MD (2008). Artificial ripening: What we were eating. Journal of Medicine 9:42-44.

Biro Pusat Statistik dan Direktorat Jenderal Hortikultura (2014a). Produksi Pisang Menurut Propinsi 2011 – 2015. Kementerian Pertanian RI. 0. Access January, 2017.

Biro Pusat Statistik danDirektorat Jenderal Hortikultura (2014b). Luas Panen Pisang Menurut Propinsi 2011 – 2015. Kementerian Pertanian RI. http://www.pertanian.go.id/ap_pages/mod/datahorti. Access January, 2017.

Daniels J, Keefe VO, Smyth H, Gething K, Fanning K, Telford P (2013). Planet of the cavendish – understanding the domination. In.Proc. Int. ISHS-ProMusaSymp. on bananas and plantains: towards sustainable global production and improved uses. Eds.: I. Van den Bergh et al. Acta Horticulturae 986, ISHS 2013

Hermanto C, Edison HS, Nasution F, Riska, Malia E, Nofriarjasri, Daniels J, Sutanto A, Hilman Y (2012). Triangle banana exploration report, North Sulawesi and North Maluku, Indonesia. AIAT, Medan, ITFRI, Solok Sumatra, AIAT North Sulawesi, AIAT North Maluku, Agri-Science Queensland, ICHORD Jakarta. file:///C:/Users/Ivwighren/Downloads/IN140114.pdf

Hiariej A, Karuwal RL (2015). Profil lingkungan tumbuh pisang tongka tlangit (*Musa troglodytarum* L.) di Kabupaten Maluku Tengah.BioWallacea Jurnal Ilmiah Ilmu Biologi 1(1):59-63. ISSN: 2442-2622.

Kagy V, Wong M, Vandenbroucke H, Jenny C, Dubois C, Olliver A, Cardi C, Mournet P, Tuia VS, Roux N, Dolezel J, Perrier X (2016). Traditional banana diversity in Oceania: An endangered heritage. PLoS ONE 11(3):e0151208.

Kepler AK (2007). Banana cultivar names and synonyms in Hawai'I (excluding traditional mai'a). http://.ctahr.hawaii.edu/nelson/...nymsHawaii.pdf

Lencer CC (2017). BY-SA 3.0.https://en.m.wikipedia.org/wiki/Ambo_Island. Access date June, 2017. Last edited 4 Months ago by Marek69.

Nomura ES, Moraes WS, Junior ERD, Fuzitani EJ, Saes LA, Amorim EP, Silva SO (2013). Evaluation of banana genotypes over two crop cycles under subtropical conditions in the riberia valley Sao Paulo Brazil. In VII International Symposium on Banana: ISHS-ProMusa Symposium on Bananas and Plantains: Towards Sustainable Global Production 986:61-70.

Pillay M, Ogundiwin E, Tenkuano A, Dolezel J (2006). Ploidy and genome composition of Musa germplasm at the International Institute of Tropical Agriculture (IITA). African Journal of Biotechnology 5(13):1224-1232.

Ploetz RC (2001). Black Sigatoka of banana: The most important disease of a most important fruit. The plant health instructor. DOI: 10.1094/PHI-I-2001-0126-02.

Sutanto A, Edison HS, Riska, Alfons, Daniels J (2013). Central Maluku banana varieties–A Work in Progress file:///C:/Users/Ivwighren/Downloads/IN140113.pdf

Sutanto A, Edison HS, Riska, Nasution E, Hermanto C, Cizkova J, Hribova E, Dolezel J, Roux N, Horry JP, Daniells JW, De Langhe E

(2016). Collecting banana diversity in eastern Indonesia. In XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): IX 1114 (pp. 19-26).
Utton D (2017). Bananas face extinction due to spread of unstoppable deadly fungus. Express. Home of Dayly and Sundays express. Mon, Oct 16, 2017.
Valmayor RV, Jamaluddin SH, Silayoi B, Kusumo S, Dahn LD, Pascua OC, Espino RRC (2000). Banana cultivar names and synonyms in Southeast Asia.International Network for the Imporvement of Banana and Plantain-Asia and the Pacific Office, Los Banos, Laguna, Philippines.INIBAB.ISBN 971-91751-2-5.
Van der Waal JWH (2010). Exporting bananas for improved livelihoods and social development: experiences and challenges from Latin America and Africa. In Proc. IC on Banana & Plantain in Africa, Eds.: T. Dubois et al. Acta Hort. 879, ISHS 2010
Wikipedia, Banana Kepok. https://id.m.wikipedia.org/wiki/Pisang_kepok. Access October, 2018.

Annex 1.

QUESTIONNAIRE
For Market Interview
1. Enumerator :
2. Name of the Market:
3. Date of interview:
4. Name of the trader:
5. Amount of banana/plantain trading: …….hands/….bunches
6. Kinds/cultivars/land races of banana/plantain trading: (pictures of fruits, hands, bunch for each kind taken).
7. Price per quantity (fruit/hand/bunch) trading:
8. Size of a bunch (number of hands per bunch):
9. Size of a hand (Number of fruits/fingers per hand):
10. Fruit's length (taken from a number of fruits):
11. Fruit's circle (taken from a number of fruits):
12. Fruit's color: (yellow, white, red, light green, dark green …):
13. Source of banana/plantain (where do they come from): Ambon island, Ceram island, Buru island, other island
14. Where do they produced: trader's own yard, trader's own planting field (dusun), trader's own plantation, collected from other farmers
15. How do they get to the market: loaded in the truck, carry by ship/ferry, collected from other traders in the market
16. How do the banana/plantain prepared before transported: open, using packeging
17. If any banana/plantain sold well than others: cultivars name…
18. If any kinds are well sold, what is/are the reasons?:
19. How long the banana/plantain stay in the market for sale :
20. How are the banana/plantain processed for consumption: raw, boil, fried, baby's food, cracker, juice, animal feed, starch production…
21. Do the traders use book keeping:
22. Are there any tax/retributions to pay:
23. Are there any governmental assistance to support the traders:
24. How is the market management:
25. Other additional questions:
Notes: For every kind of banana/plantain, one questionnaire is used; Pictures are taken from every kind of banana/plantain

Annex 2.

QUESTIONNAIRE II
For Field and business management interview
1. Enumerator:
2. Name of plantation location/place:
3. Date of interview:
4. Name of the farmer/plantation manager/stake holder:
5. Cultivated area:
6. Kinds of banana/plantain cultivated:
7. Most cultivated cultivars:
8. Cropping system: Monoculture, multiple cropping, dusun system, others
9. Way of seed provision: self-collecting, buying from other seeds providers, buying from the government institution
10. Ways of preparing the land/planting field: self-clearing, joint work with community group, hire the workers.
11. Planting date: Month…
12. Ways of planting: directly planted into the soil, using organic matters …
13. Un-organic fertilizers used: Nitrogen, Phosphorous, Potassium
14. Date of pruning
15. Number of employee needed:
16. Cost of pruning:
17. Pests found:
18. Diseases found:
19. Measurements for pests control taken:
20. Measurements for diseases control taken:
21. When pesticides use, what kind of pesticides:
22. Dose of pesticides:
23. Number of employee needed:
24. Cost of pests and diseases control:
25. Other cultural practices implemented:
26. Cost of those cultural practices:
27. Time of harvest:
28. Is there any harvesting procedure:
29. Frequency of harvest in a year:
30. Marketing procedure: the stake holder bring to the market, the traders buy in the plantation site,…
31. Packaging for marketing:
32. If sold at the planting site, how much the price per the amount specified:
33. Are there any training/workshop for the employee:
34. Is there any governmental assistance on the business:
35. Is there any joint work with other stake holders:
36. Is there any national and/or international joint work:
37. Is there any calculation of benefit cost:
38. Other questions:
Notes: For every kind/cultivars of banana/plantain, separate questionnaire will be used; Pictures are taken on different cultivars, kinds of cultural activities, business activities, etc.